Clinical Update

Naval Postgraduate Dental School
National Naval Medical Center
8901 Wisconsin Ave
Bethesda, Maryland 20889-5600

Vol. 33 No. 10 2011

Endodontic Irrigation Armamentarium

Lt Verne F. Reed, DC, USN, CAPT Terry D. Webb, DC, USN

Introduction

The main cause of endodontic infection is the presence of bacteria and their byproducts within the root canal system.[1] Therefore, one of the primary objectives of endodontic therapy is to eliminate bacteria from the canal. In order to more predictably accomplish this goal, it is important to clean, shape, and obturate the canal system. Root canal systems present an infinite variety of complex anatomy that makes it impossible for endodontic files to completely clean the root canal walls. Therefore, the practice of endodontics relies heavily on endodontic irrigants to facilitate removal of bacteria and debris from the canals. Recent advances in endodontic irrigation armamentarium suggest that it might be possible for practitioners to obtain a higher level of disinfection within the tooth than ever before. The purpose of this report is to provide a review of current endodontic irrigation techniques and to identify irrigation armamentarium that have recently become available to aid the clinician in reducing the bacterial load and debris within the canal system.

Root Canal Shape

In order to obtain the therapeutic effects of endodontic irrigation, the irrigant must have unimpeded physical access to the surfaces it is trying to disinfect. This can be a particular challenge, and also be of extreme importance when dealing with the apical third of the canal. Studies show that increasing apical preparation size will allow for greater irrigant delivery and result in reducing the amount of bacteria at the apex.[2] When comparing the effects of both size and taper on irrigant flow in the apical portion of the root canal, Boutsioukis et al. reported that increasing the apical size and taper not only increases irrigant flow when using a 30 gauge side vented irrigation tip, but also reduces shear stresses on the canal walls and relieves pressure at the apex.[3,4] Additionally, Brunson et al. reported that preparing the apex to ISO #40/.04 will provide the maximum significant irrigant volume while preserving as much tooth structure as possible when using apical negative pressure.[5]

Irrigants

A variety of irrigants are available to effectively aid the practitioner in removing bacteria and debris from the root canal system. For a more detailed update on endodontic irrigants, please refer to the 2010 Clinical Update, Vol. 32, No. 3, titled *Endodontic Irrigants*.

Irrigation Tip Gauge and Tip Design

Irrigation tip gauge and tip design can have a significant impact on the irrigation flow pattern, flow velocity, depth of penetration, and pressure on the walls and apex of the canal. These factors can have a direct influence on irrigant efficacy and patient safety. Sedgley et al. showed that as the placement of the irrigant tip approaches the working length of the canal, the bacterial reduction increases.[6] Irrigation tip gauge will largely determine how deep an irrigant can penetrate into the canal. A 21-gauge tip can reach the apex of an ISO size 80 canal, a 23-gauge tip can reach a size 50, a 25-gauge tip can reach a size 35 canal and a 30-gauge tip can reach the apex of a size 25 canal.[7] Irrigant tips are often classified as either being open or closed-ended. Open-ended tips express irrigant out the end towards the apex and consequently increase the apical pressure within the canal. Closed-ended irrigant tips are side-vented and thus create more pressure on the walls of the root canal. When comparing the effectiveness of different irrigation tip designs, Kahn et al. discovered that the closed-ended design of the Max-i-probe was more effective than open-ended tip configurations at clearing dye from simulated canals.[8] Studies confirm that because of the side-vented design of a closed-ended irrigant tip, irrigant is expressed only 1.0 – 1.5mm past the tip.[9] Therefore, while generally considered being safer for the patient, a closed-ended irrigant tip should be placed within 1 mm of the working length to reduce bacteria and debris at the apex.

Agitation Techniques

Dynamic irrigation is defined as vigorously agitating the irrigant within the canal system.[10] Irrigant agitation can be accomplished through a variety of methods and is often compared to static irrigation, or the lack of agitation. Irrigant agitation techniques are sometimes categorized as either manual or machine driven.[10] Manual agitation can be performed by employing short rapid strokes with an irrigant tip, a small endodontic file[11], an endodontic microbrush (NaviTip FX, Endobrush) [12] or with a well fitting gutta percha cone.[13] Machine driven techniques accomplish the same goal as irrigant agitation, but do so through the use of electrical devices, such as rotary brushes (Ruddle brush; CanalBrush), continuous irrigation during rotary instrumentation (Quantec-E), sonic irrigation (EndoActivator), ultrasonic irrigation, and negative pressure irrigation devices (EndoVac, RinsEndo). While studies have shown that dynamic irrigation can be more effective at removing debris in the canal system when compared to static irrigation[14,15], the labor intensive nature of manual techniques could make them less favorable when compared to machine driven agitation techniques.

Passive Ultrasonic Irrigation (PUI)

Passive ultrasonic irrigation is a form of a machine-driven dynamic irrigation technique that utilizes ultrasonic vibrations to agitate irrigant in a canal. When an endodontic file is placed passively in an irrigant-filled canal and is activated with an ultrasonic energy source, it will create a highly disruptive pattern of fluid flow that is known as *acoustic streaming*.[16] In vivo studies have shown that one minute of PUI has been shown to decrease debris [17] as well as the bacterial load [18] in canals and ismuthes when compared to static irrigation techniques.

Positive Pressure vs. Negative Pressure Irrigation

Negative pressure irrigation is a technique that uses an irrigation/delivery tip that is connected by small tubing to the high-speed suction of the dental chair to "pull" the irrigant into the canal system. As the delivery/evacuation tip is placed to the desired depth in the canal, the high-speed suction uses negative pressure to actively draw the irrigant from a flooded pulp chamber down the canal to the cannula tip where it is removed from the canal through the tip and tubing.[19] Negative pressure techniques differ from positive pressure techniques in that instead of the irrigant being pulled into the canal through the use of suction, it is actively pushed into the canal by the operator through an irrigation tip. Negative pressure irrigation attempts to address the challenge of maximizing the ability of the irrigant to access the working length of the canal while minimizing the chance of extruding irrigant out the apex. A number of commercially available negative pressure devices have been compared in the dental literature. Multiple studies comparing the negative pressure device, EndoVac, to positive pressure techniques show EndoVac to be more effective at reducing debris in the apical 1 mm of the canal,[19] reducing the bacterial load [20] and extruding less irrigant out the apex. [21]

Conclusion

Root canal irrigation is a rapidly evolving component within the modern practice of endodontics. Today's irrigation armamentarium presents a diverse variety of tools and techniques that can assist the practitioner in reducing bacteria and debris within the canal system. However, currently there is no universally accepted standard irrigation technique. Since most research comparing the efficacy of different irrigation techniques are in vitro studies with low levels of clinical evidence, caution is advised when considering the purchase of these devices. To date, no research has determined that the use of any of these devices or various irrigation techniques have a more favorable healing outcome with endodontic treatment.

References

1. Kakehashi S, Stanley HR, Fitzgerald RJ. The effects of surgical exposures of dental pulps in germ-free and conventional laboratory rats. Oral Surg Oral Med Oral Pathol 1965 Sep;20(3):340–9.
2. Falk KW, Sedgley CM. The influence of preparation size on the mechanical efficacy of root canal irrigation in vitro. J Endod 2005 Oct;31(10):742-5.
3. Boutsioukis C, Gogos C, Verhaagen B, Versluis M, Kastrinakis E, Van der Sluis LW. The effect of root canal taper on the irrigant flow: evaluation using an unsteady Computational Fluid Dynamics model. Int Endod J 2010 Oct;43(10):909-16.
4. Boutsioukis C, Gogos C, Verhaagen B, Versluis M, Kastrinakis E, Van der Sluis LW. The effect of apical preparation size on irrigant flow in root canals evaluated using an unsteady Computational Fluid Dynamics model. Int Endod J 2010 Oct;43(10):874-81.
5. Brunson M, Heilborn C, Johnson DJ, Cohenca N. Effect of apical preparation size and preparation taper on irrigant volume delivered by using negative pressure irrigation system. J Endod 2010 Apr;36(4):721-4.
6. Sedgley CM, Nagel AC, Hall D, Applegate B. Influence of irrigant needle depth in removing bioluminescent bacteria inoculated into instrumented root canals using real-time imaging in vitro. Int Endod J 2005 Feb;38(2):97-104.
7. Chow TW. Mechanical effectiveness of root canal irrigation. J Endod 1983 Nov;9(11):475-9.
8. Kahn FH, Rosenberg PA, Gliksberg J. An in vitro evaluation of the irrigating characteristics of ultrasonic and subsonic handpieces and irrigating needles and probes. J Endod 1995 May;21(5):277-80.
9. Boutsioukis C, Verhaagen B, Versluis M, Kastrinakis E, Wesselink PR, van der Sluis LW. Evaluation of irrigant flow in the root canal using different needle types by an unsteady computational fluid dynamics model. J Endod 2010 May;36(5):875-9.
10. Gu LS, Kim JR, Ling J, Choi KK, Pashley DH, Tay FR. Review of contemporary irrigant agitation techniques and devices. J Endod 2009 Jun;35(6):791-804.
11. Abou-Rass M, Piccinino M. The effectiveness of four clinical irrigation methods on the removal of root canal debris. Oral Surg Oral Med Oral Pathol Oral Radiol Endod 1982 Sep;54(3):323-8.
12. Al-Hadlaq SM, Al-Turaiki SA, Al-Sulami U, Saad AY. Efficacy of new brush-covered irrigation needle in removing root canal debris: a scanning electron microscopic study. J Endod 2006 Dec;32(12):1181-4.
13. McGill S, Gulabivala K, Mordan N, Ng YL. The efficacy of dynamic irrigation using a commercially available system (RinsEndo) determined by removal of a collagen 'bio-molecular film' from an ex vivo model. Int Endod J 2008 Jul;41(7):602-8.
14. Bronnec F, Bouillaguet S, Machtou P. Ex vivo assessment of irrigant penetration and renewal during the final irrigation regimen. Int Endod J 2010 Aug;43(8):663-72.
15. Huang TY, Gulabivala K, Ng YL. A bio-molecular film ex-vivo model to evaluate the influence of canal dimensions and irrigation variables on the efficacy of irrigation. Int Endod J 2008 Jan;41(1):60-71.
16. Ahmad M, Pitt Ford TR, Crum LA. Ultrasonic debridement of root canals: an insight into the mechanisms involved. J Endod 1987 Mar;13(3):93-101.
17. Burleson A, Nusstein J, Reader A, Beck M. The in vivo evaluation of hand/rotary/ultrasound instrumentation in necrotic, human mandibular molars. J Endod 2007 Jul;33(7):782-7.
18. Carver K, Nusstein J, Reader A, Beck M. In vivo antibacterial efficacy of ultrasound after hand and rotary instrumentation in human mandibular molars. J Endod 2007 Sep;33(9):1038-43.
19. Nielsen BA, Craig Baumgartner J.Comparison of the EndoVac system to needle irrigation of root canals. J Endod 2007 May;33(5):611-5.
20. Hockett JL, Dommisch JK, Johnson JD, Cohenca N. Antimicrobial efficacy of two irrigation techniques in tapered and nontapered canal preparations: an in vitro study. J Endod 2008 Nov;34(11):1374-7.
21. Mitchell RP, Yang SE, Baumgartner JC. Comparison of apical extrusion of NaOCl using the EndoVac or needle irrigation of root canals. J Endod 2010 Feb;36(2):338-41.

Lieutenant Reed is an endodontic resident and Commander Webb is the Department Chairman and Residency Program Director, Department of Endodontics, Naval Postgraduate Dental School, Navy Medicine Manpower Personnel Training and Education Command.